DYNAMIC PRESSURE TYPE OIL-IMPREGNATED SINTERED BEARING AND MANUFACTURE THEREOF

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Abstract

PROBLEM TO BE SOLVED: To perform molding of a bearing surface having an inclination-form dynamic groove through simple equipment with the reduced number of processes, and with high precision.

SOLUTION: After a sintered, metallic material 1' is registered with the upper surface of a die 20 and arranged, an upper punch 22 and a core rod 21 are lowered. The sintered metallic material 1' is pressed in a die 20 and further pressed against a lower punch 23 and pressurized from a vertical direction. The sintered metallic elements 1' receives a press force from a die 20 and upper and lower punches 22 and 23 and is brought into deformation, an inner peripheral surface is pressurized by the molding tool 21a of a core rod 21, plastic fluid is generated and bites the molding tool 21a. This constitution transfers the shape of the molding tool 21a on the inner peripheral surface of the sintered metallic material 1' and molds a bearing surface having a dynamic pressure groove.

Bibliography

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Epitome

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(57) [Abstract]
[Technical problem] With simple equipment, it is a small man day and fabrication of the bearing surface which has the dynamic pressure slot of the letter of an inclination is performed with a sufficient precision.
[Means for Solution] After carrying out alignment of sintered-metal material 1' to the upper surface of a die 20 and arranging it on it, top punch 22 and a core rod 21 are dropped, sintered-metal material 1' is pressed fit in a die 20, and it pushes against bottom punch 23 further, and pressurizes from the upper and lower sides. In response to pressure force, a lifting and inner skin are pressurized by die 21a of a core rod 21 in deformation from a die 20 and vertical punch 22-23, and sintered-metal material 1' starts plastic flow, and bites die 21a. Thereby, a configuration of die 21a is imprinted by inner skin of sintered-metal material 1', and the bearing surface which has a dynamic pressure slot of a letter of an inclination is fabricated.

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1] A porous bearing main part with which the bearing surface which has a dynamic pressure slot of a letter of an inclination in inner skin was formed An oil held by impregnation of a lubricating oil or lubricating grease in pore inside the above-mentioned bearing main part Are the manufacture method of a dynamic pressure mold porosity oilless bearing equipped with the above, and a die which has the 2nd shaping section for fabricating the 1st shaping section for fabricating a formation field of a dynamic pressure slot in the above-mentioned bearing surface and fields other than a formation field of a dynamic pressure slot is inserted in inner skin of a cylinder-like porosity material. It is characterized by including a production

process which carries out coincidence shaping of a formation field of a dynamic pressure slot in the above-mentioned bearing surface, and the other field in inner skin of the above-mentioned porosity material by applying pressure force to the above-mentioned porosity material, and pressurizing inner skin of the above-mentioned porosity material at the above-mentioned die.

[Claim 2] A manufacture method of a dynamic pressure mold porosity oilless bearing according to claim 1 that the above-mentioned porosity material is formed with a sintered metal.

[Claim 3] A manufacture method of a dynamic pressure mold porosity oilless bearing according to claim 2 that the above-mentioned sintered metal uses copper, iron, or its both as a principal component.

[Claim 4] A manufacture method of a dynamic pressure mold porosity oilless bearing according to claim 1, 2, or 3 which releases the above-mentioned die from mold from inner skin of the above-mentioned porosity material using springback of the above-mentioned porosity material by canceling the above-mentioned pressure force after fabricating the above-mentioned bearing surface.

[Claim 5] A porous bearing main part with which the bearing surface which has a dynamic pressure slot of a letter of an inclination in inner skin was formed An oil held by impregnation of a lubricating oil or lubricating grease in pore inside the above-mentioned bearing main part Are the manufacture method of a dynamic pressure mold porosity oilless bearing equipped with the above, and a die which has the 2nd shaping section for fabricating the 1st shaping section for fabricating a formation field of a dynamic pressure slot in the above-mentioned bearing surface and fields other than a formation field of a dynamic pressure slot is used as an inner mold. It is characterized by including a production process which carries out coincidence shaping of a formation field of a dynamic pressure slot in the above-mentioned bearing surface, and the other field in inner skin of the above-mentioned compression-molding object with the above-mentioned die at the same time it fabricates a cylinder-like compression-molding object from a powder material with compression molding.

[Claim 6] A manufacture method of a dynamic pressure mold porosity oilless bearing according to claim 5 that the above-mentioned powder material is a powder metal material.

[Claim 7] A manufacture method of a dynamic pressure mold porosity oilless bearing according to claim 6 that the above-mentioned powder metal material uses copper, iron, or its both as a principal component.

[Claim 8] A manufacture method of a dynamic pressure mold porosity oilless bearing according to claim 5, 6, or 7 which releases the above-mentioned die from mold from inner skin of the above-mentioned compression-molding object using springback of the above-mentioned compression-molding object by canceling compression-molding force after fabricating the above-mentioned compression-molding object.

[Claim 9] A dynamic pressure mold porosity oilless bearing manufactured by the manufacture method given in any of claim 1 - claim 8 they are.

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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] While this invention carries out impregnation of a lubricating oil or the lubricating grease to the bearing main part which consists of porosity objects, such as a sintered metal, and gives a self-lubrication function to it It is related with the dynamic pressure mold porosity oilless bearing which carries out non-contact support of the sliding surface of a shaft by the lubricating oil film formed of a dynamic pressure operation of a dynamic pressure slot. Especially like the device by which high rotation precision is demanded under a high speed and the spindle motors for DVD-ROM, such as a spindle motor the object for the polygon mirrors of a laser beam printer (LBP), and for magnetic disk drives (HDD etc.) When a disk appears, it is suitable for bearing, such as a device which a big imbalance load acts and is driven at high speed.

[0002]

[Description of the Prior Art] Much more improvement and low-cost-izing of rotationability are called for, and transposing bearing of a spindle to a porosity oilless bearing from anti-friction bearing is considered as a means for it by the small spindle motor of the above information-machines-and-equipment relation. However, since a porosity oilless bearing is a kind of a cylindrical bearing, when the eccentricity of a shaft is small, it has the defect which unstable oscillation tends to generate and the so-called HOWARU around which sways at the rate of one half of rotational speed, and it turns tends to generate. Then, to establish dynamic pressure slots, such as a herringbone form and a spiral form, in the bearing surface, to make a lubricating oil film form in a bearing clearance according to an operation of the dynamic pressure

slot accompanying rotation of a shaft, and to carry out non-contact support of the shaft is tried conventionally (dynamic pressure mold porosity oilless bearing).

[0003] As conventional technology in which the dynamic pressure slot was formed to the bearing surface of a porosity oilless bearing, the thing of a publication is in utility model public notice Showa 63 year 19627 No. Technology given [this] in a number performs surface powdery-substance-to-fling-in-the-eyes processing to the formation field of the dynamic pressure slot in the bearing surface, and seals the formation field of a dynamic pressure slot. Moreover, the method of pressurizing a ball at material inner skin and carrying out plastic working of the formation field of a dynamic pressure slot is learned, inserting in the inner skin of a bearing material the fixture of the shape of a shaft which carried out array maintenance of two or more hard balls at circumference regular intervals, and giving screw motion to a ball by rotation of a fixture and delivery rather than a bearing material, as the shaping method of the dynamic pressure slot in the bearing surface, (JP,2541208,B).

[0004]

[Problem(s) to be Solved by the Invention] The following troubles arise with the configuration indicated by utility model public notice Showa 63 year 19627 No. First, since sealing of the formation field of a dynamic pressure slot is carried out completely, in the field, circulation of the oil which is the greatest feature of a porosity oilless bearing is checked. Therefore, the oil which once oozed out to the bearing clearance will be stuffed into the shaft-orientations center section of the bearing surface by operation of a dynamic pressure slot, and will remain there according to it. Since the big shear operation within a bearing clearance is working, the oil which remained in the bearing clearance with the shearing force and frictional heat is in the orientation in which is easy to denaturalize and oxidation degradation is rash with a temperature rise. Therefore, a bearing life becomes short. Although coating besides plastic working etc. is listed next as other means to perform surface powdery-substance-to-fling-in-the-eyes processing, it is very difficult to make thickness of a coating coat thinner than a channel depth, and to give the coating coat which is several micrometers only to the formation field of a dynamic pressure slot.

[0005] Moreover, by the method indicated by JP,2541208,B, since material upheaval takes place in the field which adjoins a dynamic pressure slot at the time of shaping, it is necessary to carry out removal processing of this with a lathe or a reamer (patent public presentation 8 [Heisei] No. 232958 per year). Therefore, a manufacture man day increases. Moreover, since the rotation drive and delivery device of a fixture are required, a manufacturing facility becomes complicated. Furthermore, since it is necessary to fix a bearing material by the chuck, the bearing surface deforms according to the chuck force, or deviation arises in coaxiality with a peripheral face.

[0006] The purpose of this invention is to secure circulation of the suitable oil between the interior of a bearing main part and a bearing clearance, control

deterioration of the oil in a bearing clearance, and raise a bearing life while offering the manufacture method that it is simple equipment, and it is a small man day and fabrication of the bearing surface which has the dynamic pressure slot of the letter of an inclination can be performed with a sufficient precision.
[0007]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention inserts in inner skin of a cylinder-like porosity material a die which has the 2nd shaping section for fabricating the 1st shaping section for fabricating a formation field of a dynamic pressure slot in the bearing surface, and fields other than a formation field of a dynamic pressure slot. It considered as a configuration which carries out coincidence shaping of a formation field of a dynamic pressure slot in the bearing surface, and the other field at inner skin of a porosity material by applying pressure force to a porosity material and pressurizing inner skin of a porosity material at a die. Or while fabricating a cylinder-like compression-molding object from a powder material with compression molding by using the above-mentioned die as an inner mold, it considered as a configuration which carries out coincidence shaping of a formation field of a dynamic pressure slot in the bearing surface, and the other field with a die at inner skin of a compression-molding object. Mold release of the above-mentioned die can be performed using springback of a compression-molding object by canceling compression-molding force, using springback of a porosity material by canceling the above-mentioned pressure force.
[0008]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained.
[0009] Drawing 1 has illustrated one gestalt of the dynamic pressure mold porosity oilless bearing manufactured by the manufacture method of this invention. This porosity oilless bearing 1 enables non-contact support of the rotation of the spindle shaft 4 which carries out high-speed rotation by the example magnetism between Rota 2 and a stator to housing 5 in the scanner motor of a laser beam printer as shown in drawing 2 .
[0010] The porosity oilless bearing 1 consists of porous bearing main part 1a and an oil held by the impregnation of a lubricating oil or lubricating grease in the pore of bearing main part 1a. For bearing main part 1a, it is formed with copper, iron, or the sintered metal that uses the both as a principal component, copper is contained 20 to 95% of the weight desirably, and density is 3 6.4-7.2g/cm. It is formed so that it may become. As the quality of the material of bearing main part 1a, what used cast iron, synthetic resin, the ceramics, etc. as sintering or the porosity object which carries out foaming and has much pores may be used.
[0011] Bearing surface 1b which counters the inner skin of bearing main part 1a through the peripheral face and bearing clearance of a shaft which should be supported is formed, and dynamic pressure slot 1c of the letter of an inclination is formed in the bearing surface 1b. The 1st field m1 which arranged two or more

dynamic pressure slot 1c toward which bearing surface 1b in this operation gestalt inclined in one side to shaft orientations to the circumferencial direction, It is isolated from the 1st field m1 to shaft orientations, and consists of annular smooth fields n located between the 2nd field m2 which arranged two or more dynamic pressure slot 1c which inclined on another side to shaft orientations to the circumferencial direction, and the 1st field m1 and the 2nd field m2. The back of 1d of the 1st field m1 (field between dynamic pressure slot 1c) and the back of 1d of the 2nd field m2 (field between dynamic pressure slot 1c) are following the smooth field n, respectively. Dynamic pressure slot 1c of the 1st field m1 and dynamic pressure slot 1c of the 2nd field m2 are bilateral symmetry to the shaft-orientations center line of bearing surface 1b. Surface puncturing is distributed over bearing surface 1b over all fields including the formation field of dynamic pressure slot 1c, an oil is mainly circulated between the interior of bearing main part 1a, and a bearing clearance through surface puncturing of bearing surface 1b, and it has composition which carries out non-contact support of the peripheral face of a shaft to bearing surface 1b. for example, surface hole density -- the 1st field m1 and the 2nd field m2 -- setting -- 5 - 40% of range -- desirable -- 5 - 20% of range -- setting up -- the smooth field n -- setting -- 2 - 30% of range -- it can be desirably set as 2 - 10% of range. Moreover, surface hole density of the smooth field n can be made smaller than the surface hole density of the 1st field m1 and the 2nd field m2. Here, the area rate of surface puncturing that say the portion to which the pore of porosity body tissue carried out the opening of "the surface puncturing" to the outside surface, and "surface hole density" occupies it in the unit area of an outside surface is said.

[0012] If relative rotation arises between bearing main part 1a and a shaft, since the oil in a bearing clearance will be drawn in the 1st field m1 and the 2nd field m2 by the reverse sense towards the smooth field n by dynamic pressure slot 1c by which inclination formation was carried out, respectively and an oil will be brought together in the smooth field n, the oil film pressure in the smooth field n is heightened. Therefore, the formation effect of a lubricating oil film is high. And since it becomes the back face to which the smooth field n supports a shaft in addition to the back of 1d, a back-face product is expanded and bearing rigidity is raised. The ratio r of the shaft-orientations width of face of the smooth field n is good desirably the range of r=0.1-0.6, and to set it as the range of r=0.2-0.4, when bearing width of face is set to 1. In addition, the continuation configuration of shaft orientations as shown in drawing 3 is [that what is necessary is just the configuration which inclined to shaft orientations] sufficient as dynamic pressure slot 1c, or a spiral configuration is sufficient as it (it does not have an annular smooth field in this case.).

[0013] Drawing 4 shows the flow of the oil O in the shaft-orientations cross section at the time of supporting a shaft 4 by the porosity oilless bearing 1 of the above-mentioned configuration. With rotation of a shaft 4, the oil O held in the pore inside bearing main part 1a oozes out to a bearing clearance from shaft-orientations both

sides and near the chamfer section bearing surface 1b, and is further drawn by the dynamic pressure slot towards the center of shaft orientations of a bearing clearance. The pressure of the oil film by which it is placed between bearing clearances is heightened by drawing-in operation (dynamic pressure operation) of the oil O, and a lubricating oil film is formed of it. With the lubricating oil film (lubricating oil film formed of a dynamic pressure operation of a dynamic pressure slot) formed in this bearing clearance, non-contact support of the shaft 4 is carried out to bearing surface 1b, without producing unstable oscillation, such as HOWARU. With the developed pressure accompanying rotation of a shaft 4, the oil O which oozed out to the bearing clearance mainly circulates through the interior of return and bearing main part 1a inside bearing main part 1a from surface puncturing of bearing surface 1b, and oozes out from bearing surface 1b and near the chamfer section to a bearing clearance again.

[0014] Bearing main part 1a of the porosity oilless bearing 1 shown in drawing 1 can press copper, iron, or the metal powder that uses the both as a principal component, and can perform and manufacture sizing -> rotation sizing -> bearing surface fabrication as opposed to sintered-metal material 1' of the shape of a cylindrical shape as shown in drawing 12 which calcinated further and was obtained.

[0015] A sizing production process is a production process which performs sizing of the peripheral face of sintered-metal material 1', and inner skin, and it presses a sizing pin (cross-section round shape) fit in inner skin while it presses the peripheral face of sintered-metal material 1' fit in a cylinder-like die. A rotation sizing production process is a production process which performs sizing of inner skin, pressing fit in the inner skin of sintered-metal material 1' the sizing pin (cross section thing which carried out flat processing of the peripheral face of a circular pin partially, and left the circle portion to ******, such as the circumference) of a cross-section abbreviation polygon, and rotating this. A bearing surface forming cycle is a production process which carries out coincidence shaping of the formation field of dynamic pressure slot 1c of bearing surface 1b, and the other field (the back of 1d, and the annular smooth field n) by pressurizing the die of the configuration corresponding to bearing surface 1b of finished-product 1a at the inner skin of sintered-metal material 1' which performed the above sizing processings. This production process is as follows, for example.

[0016] Drawing 5 has illustrated the outline structure of the shaping equipment used by the bearing surface forming cycle. this -- equipment -- a sintered metal -- a material -- one -- ' -- a peripheral face -- pressing fit -- a cylinder -- ** -- a die -- 20 -- a sintered metal -- a material -- one -- ' -- inner skin -- fabricating -- a core rod -- 21 -- a sintered metal -- a material -- one -- ' -- both ends -- a field -- the upper and lower sides -- a direction -- from -- pressing down -- the upper and lower sides -- punch -- 22 -- 23 -- being main -- an element -- ****** -- constituting -- having . As shown in drawing 5 (b), die 21a of the shape of irregularity corresponding to the configuration of bearing surface 1b of a finished

product is prepared in the peripheral face of a core rod 21. The amount of [of die 21a / 21a1] heights fabricate the field of dynamic pressure slot 1c in bearing surface 1b, and the amount of [21a2] crevice fabricates fields other than dynamic pressure slot 1c (the back of 1d, and the annular smooth field n). Although the level difference (depth H) for a part for the heights 21a1 in die 21a and a crevice 21a2 is comparable (for example, about 2-5 micrometers) as the depth of dynamic pressure slot 1c in bearing surface 1b and minute, in the drawing, it exaggerates considerably and it is illustrated.

[0017] In the condition before the press fit to a die 20, the bore crevice T is between the inner skin of sintered-metal material 1', and die 21a (they are criteria about a part for heights 21a1) of a core rod 21. The magnitude of the bore crevice T (the amount of diameters) is 50 micrometers. The press fit cost (outer-diameter interference S: the amount of diameters) to the die 20 of the peripheral face of sintered-metal material 1' is 150 micrometers.

[0018] After carrying out alignment of sintered-metal material 1' to the upper surface of a die 20 and arranging it on it, as shown in drawing 6 , top punch 22 and a core rod 21 are dropped, sintered-metal material 1' is pressed fit in a die 20, and it pushes against bottom punch 23 further, and pressurizes from the upper and lower sides.

[0019] As for sintered-metal material 1', in response to the pressure force, a lifting and inner skin are pressurized by die 21a of a core rod 21 in deformation from a die 20 and vertical punch 22-23. The outer-diameter interference S and the surface portion from inner skin to the predetermined depth which spreads abbreviation etc. on a difference with the bore crevice T are pressurized by die 21a of a core rod 21, and the amount of pressurization of inner skin starts plastic flow, and bites die 21a. Thereby, the configuration of die 21a is imprinted by the inner skin of sintered-metal material 1', and bearing surface 1b is fabricated by the configuration and size which are shown in drawing 1 (sizing also of the peripheral face of sintered-metal material 1' is carried out to coincidence.).

[0020] After shaping of bearing surface 1b is completed, as shown in drawing 9 , in the condition [having inserted the core rod 21 in sintered-metal material 1'], it interlocks, bottom punch 23 and a core rod 21 are raised (condition of drawing 9 **), and sintered-metal material 1' is extracted from a die 20 (condition of drawing 9 **). A core rod 21 can be sampled from the inner skin of sintered-metal material 1', without breaking down dynamic pressure slot 1c, since springback will arise in sintered-metal material 1' and the inside diameter will be expanded (refer to drawing 7), if sintered-metal material 1' is extracted from a die 20 (condition of drawing 9 **). Thereby, bearing main part 1a is completed. in addition, in the manufacturing process of the usual cylindrical bearing (oil impregnated sintered bearing which does not have a dynamic pressure slot in the bearing surface) a condition [having pressed sintered-metal material 1″ fit in die 20', after performing sizing of the bearing surface (inner skin), as shown in drawing 8] -- sizing pin 21' -- {cross-

section circular: -- it does not have die 21a as shown in drawing 5 (b). It is made to go up and extracts from the inner skin of sintered-metal material 1″, and he pushes up sintered-metal material 1″ by bottom punch 23', and is trying to take out from die 20' after that. If this procedure is used for shaping of the bearing surface which has the dynamic pressure slot of the letter of an inclination, in case a sizing pin (core rod) will be sampled from the inner skin of a sintered-metal material, the configuration of a dynamic pressure slot will be broken down.

[0021] Relation with the bore crevice T, and the outer-diameter interference S and the amount of springbacks when performing the bearing surface forming cycle mentioned above to with bore phi 3, outer-diameter phi 6, and a width of face of 3mm sintered-metal material 1' to drawing 10 is shown. If a fixed correlation is between the bore crevice T, and the outer-diameter interference S and the amount of springbacks and the bore crevice T and the outer-diameter interference S are specified as shown in this drawing, you can understand that the amount of springbacks at that time is also specified. since according to the experiment sintered-metal material 1' was sampled from the core rod 21 in predetermined depth H (the depth of dynamic pressure slot 1c and abbreviation of which 2 micrometers - 3 micrometer:shaping is done -- equal.), without breaking down dynamic pressure slot 1c when setting the amount of springbacks as 4-5-micrometer (amount of diameters) degree, it is desirable to set up the bore crevice T and the outer-diameter interference S so that the amount of springbacks of this amount may be obtained. In addition, although it can release from mold without making die 21a interfere in the inner skin of sintered-metal material 1' when the amount of radii of the amount of springbacks of sintered-metal material 1' is larger than depth H Even if the amount of radii of the amount of springbacks of sintered-metal material 1' is smaller than depth H and it is the case where die 21a interferes in the inner skin of sintered-metal material 1' somewhat What is necessary is to add the amount of diameter expansion by the material elasticity of sintered-metal material 1' (the amount of radii), and just to be able to release die 21a from mold from the inner skin of sintered-metal material 1', without breaking down dynamic pressure slot 1c. Therefore, a size setup based on the above-mentioned experimental result is an example, and this invention is not restrictively interpreted by this.

[0022] In addition, after the forming cycle of bearing surface 1b is completed, you may size bearing surface 1b using the usual sizing pin (cross-section round shape). In this case, the surface hole density of these fields becomes smaller than the surface hole density of the formation field of dynamic pressure slot 1c by carrying out sizing of the back of 1d and the smooth field n in bearing surface 1b by the sizing pin. Moreover, in the forming cycle of the bearing surface, it is also possible to fabricate only the formation field of a dynamic pressure slot with a die, and to finish fields other than the formation field of a dynamic pressure slot after that by sizing (cross section a circular sizing pin use) or rotation sizing (cross section the sizing pin which carried out flat processing of the peripheral face of a circular pin partially,

and left the circle portion to ******, such as the circumference, use).

[0023] Bearing main part 1a is manufactured through the above production processes, and if impregnation of a lubricating oil or the lubricating grease is carried out to this and an oil is made to hold, the dynamic pressure mold porosity oilless bearing 1 of the gestalt shown in drawing 1 will be completed.

[0024] The comparative experiments of the axial deflection engine performance were conducted using the cylindrical bearing (oil impregnated sintered bearing which does not have a dynamic pressure slot in the bearing surface), and the dynamic pressure mold porosity oilless bearing (oil impregnated sintered bearing) manufactured by the above-mentioned method. An experiment includes trial bearing in a CD-ROM system motor as shown in drawing 13 , mounts commercial CD, and measures the axial deflection over a rotational frequency. The result is shown in drawing 11 . Compared with a cylindrical bearing, he can understand that the dynamic pressure mold porosity oilless bearing of an operation gestalt is effective in control of an axial deflection also from this drawing.

[0025] The above-mentioned operation gestalt can also perform bearing surface shaping in a foaming production process, although bearing surface shaping is performed to sintered-metal material 1'. After foaming inserts the foaming pin used as an inner mold inside a dies body and is filled up with a powder material between an inner mold and a dies body, it is a production process which carries out pressurization compression at shaft orientations and which is fabricated in the shape of a cylinder. In this foaming production process, the bearing surface of a configuration as shown [foaming and coincidence] in the inner skin of mold goods (compression-molding object) at drawing 1 can be fabricated by forming the die as shown in the peripheral face of a foaming pin at drawing 5 (b). Moreover, if the compression-molding force is removed after pressurization compression, mold goods (compression-molding object) can be extracted from a foaming pin using the springback of mold goods (compression-molding object), and the configuration of the bearing surface will not collapse at this time. A powder material is a metal powder material, for example, uses copper, iron, or its both as a principal component. The mold goods after foaming are produced commercially through a sizing production process, the impregnation production process of an oil, etc., after calcinating.

[0026] Although the case where the die of the bearing surface is released from mold using the springback of a porosity material or a compression-molding object is illustrated in the above explanation, a die is elastically made into the structure in which ****** is possible (for example, let a die be the block construction by the slit.), and the diameter of a die is made to reduce elastically and you may make it release it from mold after shaping of the bearing surface. Moreover, according to the configuration (configuration of a dynamic pressure slot) of the bearing surface, the bearing surface of various configurations can be similarly fabricated by changing the configuration of a die. Furthermore, also when it is isolated to shaft orientations and forms two or more bearing surfaces in the inner skin of one bearing main part,

coincidence shaping of two or more bearing surfaces can be carried out by using for a peripheral face the core rod and foaming pin which isolated and formed two or more dice in shaft orientations.

[0027]

[Effect of the Invention] Since coincidence shaping of all the fields of the bearing surface is carried out using the die which has the 2nd shaping section for fabricating the 1st shaping section for fabricating the formation field of a dynamic pressure slot, and fields other than the formation field of a dynamic pressure slot according to this invention, with simple equipment, it is a small man day and fabrication of the bearing surface which has the dynamic pressure slot of the letter of an inclination can be performed with a sufficient precision. Moreover, since it is also possible to perform foaming of a bearing main part and bearing surface shaping to coincidence, it is advantageous also in respect of improvement in productivity, and cost reduction.

[0028] While the dynamic pressure mold porosity oilless bearing manufactured by the manufacture method of this invention has a high shaping precision of the bearing surface, its formation effect of a lubricating oil film is high since surface puncturing is distributed over all the fields of the bearing surface which moreover includes the formation field of a dynamic pressure slot and circulation of the suitable oil between the interior of a bearing main part and a bearing clearance is secured, and it has fitness and the stable bearing function, it has a high endurance life.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the drawing of longitudinal section showing one gestalt of the dynamic pressure mold porosity oilless bearing manufactured by the manufacture method of an operation gestalt.

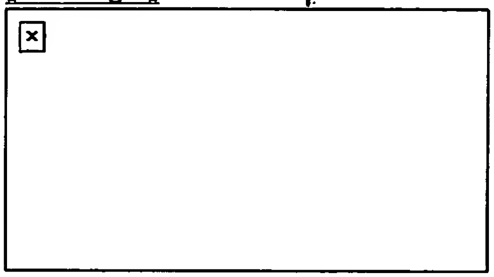
[Drawing 2] It is the drawing of longitudinal section showing the motor incorporating a porosity oilless bearing notionally.

[Drawing 3] It is the drawing of longitudinal section showing other operation gestalten of a dynamic pressure mold porosity oilless bearing.
[Drawing 4] It is drawing showing typically the flow of the oil in the shaft-orientations cross section at the time of carrying out non-contact support of the shaft by the dynamic pressure mold porosity oilless bearing.
[Drawing 5] The drawing of longitudinal section showing the outline of the shaping equipment which uses drawing 5 (a) for the fabrication of the bearing surface, and drawing 5 (b) are the side elevations showing the die which fabricates the bearing surface.
[Drawing 6] It is drawing showing the forming cycle of the bearing surface.
[Drawing 7] It is drawing showing the forming cycle of the bearing surface.
[Drawing 8] It is drawing showing the forming cycle of the bearing surface in the conventional cylindrical bearing.
[Drawing 9] It is drawing showing the forming cycle of the bearing surface of an operation gestalt.
[Drawing 10] It is drawing showing the relation between a bore crevice and an outer-diameter crevice, and the amount of springbacks.
[Drawing 11] It is drawing showing the result of having carried out the comparative study of the axial deflection at the time of using the conventional cylindrical bearing and the dynamic pressure mold porosity oilless bearing of an operation gestalt.
[Drawing 12] It is the drawing of longitudinal section showing a sintered-metal material.
[Drawing 13] It is the drawing of longitudinal section showing notionally the experimental device used for the comparative study of an axial deflection.
[Description of Notations]
1 Dynamic Pressure Mold Porosity Oilless Bearing
1a Bearing main part
1b Bearing surface
1c Dynamic pressure slot
21a Die

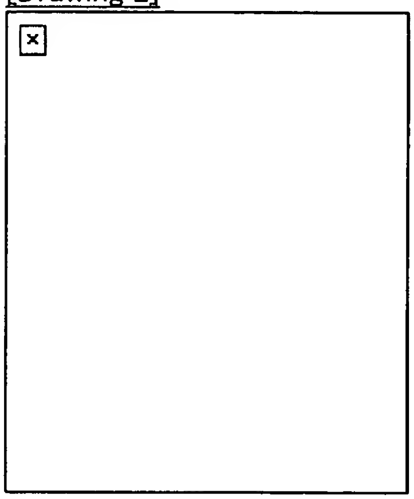
[Translation done.]

DRAWINGS

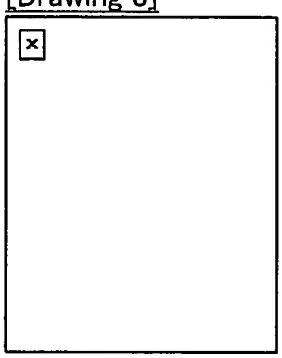
[Drawing 1]



[Drawing 2]



[Drawing 3]



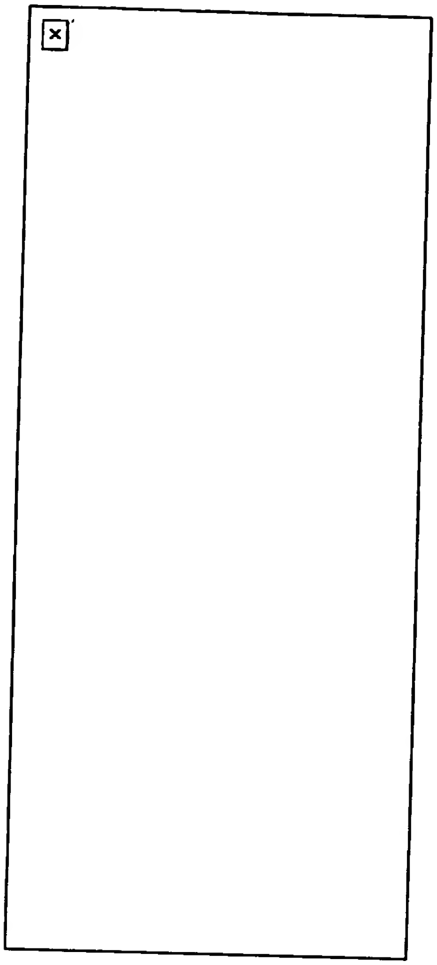
[Drawing 4]

[Drawing 6]

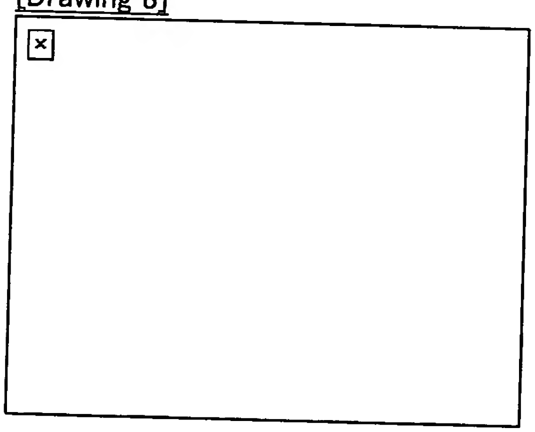
[Drawing 7]

[Drawing 12]

[Drawing 5]



[Drawing 8]



[Drawing 9]

[Drawing 10]

[Drawing 13]

[Drawing 11]

[Translation done.]

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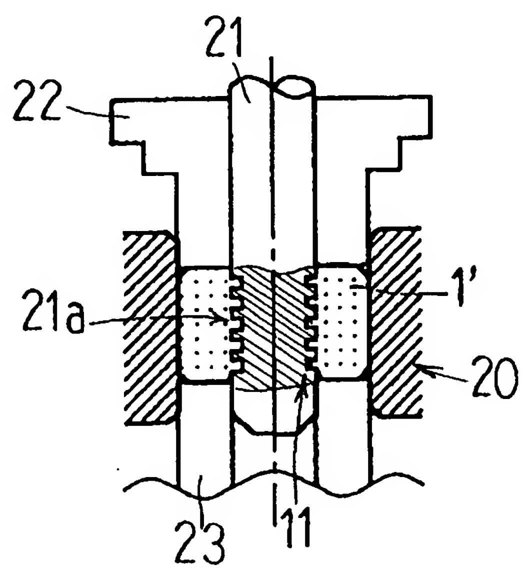
(54)【発明の名称】　動圧型多孔質含油軸受およびその製造方法

(57)【要約】

【課題】　傾斜状の動圧溝を有する軸受面の成形加工を簡易な設備で、少ない工数で、かつ、精度良く行う。

【解決手段】　焼結金属素材１’をダイ２０の上面に位置合わせして配置した後、上パンチ２２およびコアロッド２１を降下させ、焼結金属素材１’をダイ２０に圧入し、さらに下パンチ２３に押し付けて上下方向から加圧する。焼結金属素材１’はダイ２０と上下パンチ２２・２３から圧迫力を受けて変形を起こし、内周面がコアロッド２１の成形型２１ａに加圧され、塑性流動を起こして成形型２１ａに食い付く。これにより、成形型２１ａの形状が焼結金属素材１’の内周面に転写され、傾斜状の動圧溝を有する軸受面が成形される。



【特許請求の範囲】

【請求項１】 内周面に傾斜状の動圧溝を有する軸受面が形成された多孔質の軸受本体と、潤滑油又は潤滑グリースの含浸によって上記軸受本体の内部の細孔内に保有された油とを備えた動圧型多孔質含油軸受を製造するための方法であって、

上記軸受面における動圧溝の形成領域を成形するための第１成形部と動圧溝の形成領域以外の領域を成形するための第２成形部とを有する成形型を円筒状の多孔質素材の内周面に挿入し、上記多孔質素材に圧迫力を加え、上記多孔質素材の内周面を上記成形型に加圧することにより、上記多孔質素材の内周面に、上記軸受面における動圧溝の形成領域とそれ以外の領域とを同時成形する工程を含むことを特徴とする動圧型多孔質含油軸受の製造方法。

【請求項２】　上記多孔質素材が焼結金属で形成されている請求項１記載の動圧型多孔質含油軸受の製造方法。

【請求項３】　上記焼結金属が銅または鉄、あるいは、その両者を主成分とする請求項２記載の動圧型多孔質含油軸受の製造方法。

【請求項４】　上記軸受面を成形した後、上記圧迫力を解除することによる上記多孔質素材のスプリングバックを利用して、上記成形型を上記多孔質素材の内周面から離型する請求項１、２又は３記載の動圧型多孔質含油軸受の製造方法。

【請求項５】　内周面に傾斜状の動圧溝を有する軸受面が形成された多孔質の軸受本体と、潤滑油又は潤滑グリースの含浸によって上記軸受本体の内部の細孔内に保有された油とを備えた動圧型多孔質含油軸受を製造するための方法であって、

上記軸受面における動圧溝の形成領域を成形するための第１成形部と動圧溝の形成領域以外の領域を成形するための第２成形部とを有する成形型を内型として、圧縮成形により粉末材料から円筒状の圧縮成形体を成形すると同時に、上記成形型により、上記圧縮成形体の内周面に、上記軸受面における動圧溝の形成領域とそれ以外の領域とを同時成形する工程を含むことを特徴とする動圧型多孔質含油軸受の製造方法。

【請求項６】　上記粉末材料が粉末金属材料である請求項５記載の動圧型多孔質含油軸受の製造方法。

【請求項７】　上記粉末金属材料が銅または鉄、あるいは、その両者を主成分とする請求項６記載の動圧型多孔質含油軸受の製造方法。

【請求項８】　上記圧縮成形体を成形した後、圧縮成形力を解除することによる上記圧縮成形体のスプリングバックを利用して、上記成形型を上記圧縮成形体の内周面から離型する請求項５、６又は７記載の動圧型多孔質含油軸受の製造方法。

【請求項９】　請求項１～請求項８の何れかに記載の製造方法によって製造された動圧型多孔質含油軸受。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、焼結金属等の多孔質体からなる軸受本体に潤滑油あるいは潤滑グリースを含浸させて自己潤滑機能を持たせると共に、動圧溝の動圧作用によって形成される潤滑油膜で軸の摺動面を非接触支持する動圧型多孔質含油軸受に関し、特にレーザビームプリンタ（ＬＢＰ）のポリゴンミラー用や磁気ディスクドライブ（ＨＤＤ等）用のスピンドルモータなど、高速下で高回転精度が要求される機器や、ＤＶＤ－ＲＯＭ用のスピンドルモータのように、ディスクが載ることによって大きなアンバランス荷重が作用し高速で駆動する機器などの軸受に好適である。

【０００２】

【従来の技術】上記のような情報機器関連の小型スピンドルモータでは、回転性能のより一層の向上と低コスト化が求められており、そのための手段として、スピンドルの軸受部を転がり軸受から多孔質含油軸受に置き換えることが検討されている。しかし、多孔質含油軸受は、真円軸受の一種であるため、軸の偏心が小さいところでは、不安定振動が発生しやすく、回転速度の１／２の速度で振れ回るいわゆるホワールが発生しやすい欠点がある。そこで、軸受面にヘリングボーン形やスパイラル形などの動圧溝を設け、軸の回転に伴う動圧溝の作用によって軸受隙間に潤滑油膜を形成させて軸を非接触支持することが従来より試みられている（動圧型多孔質含油軸受）。

【０００３】多孔質含油軸受の軸受面に動圧溝を形成した従来技術としては、実用新案公告昭和６３年１９６２７号に記載のものがある。同号記載の技術は、軸受面における動圧溝の形成領域に表面目つぶし加工を施して、動圧溝の形成領域を封孔したものである。また、軸受面における動圧溝の成形方法として、軸受素材よりも硬質の複数個のボールを円周等間隔に配列保持した軸状の治具を軸受素材の内周面に挿入し、治具の回転と送りによってボールに螺旋運動を与えながら、ボールを素材内周面に加圧して動圧溝の形成領域を塑性加工する方法が知られている（特許２５４１２０８号）。

【０００４】

【発明が解決しようとする課題】実用新案公告昭和６３年１９６２７号に記載された構成では、次のような問題点が生じる。まず、動圧溝の形成領域が完全に封孔されているので、その領域では多孔質含油軸受の最大の特徴である油の循環が阻害される。従って、一旦軸受隙間に滲み出した油は動圧溝の作用によって軸受面の軸方向中央部に押し込まれ、そこにとどまることになる。軸受隙間内では大きな剪断作用が働いているので、その剪断力と摩擦熱によって軸受隙間内にとどまった油は変性しやすく、また、温度上昇によって酸化劣化が早まる傾向にある。従って、軸受寿命が短くなる。つぎに、表面目つ

ぶし加工を施す他の手段として塑性加工の他、コーティング等を挙げているが、コーティング被膜の厚さは溝深さよりも薄くする必要があり、数μｍのコーティング被膜を動圧溝の形成領域にのみ施すのは極めて困難である。

【０００５】また、特許２５４１２０８号に記載された方法では、成形時に動圧溝に隣接する領域で素材隆起が起こるので、これを旋盤やリーマで除去加工する必要がある（特許公開平成８年２３２９５８号）。そのため、製造工数が多くなる。また、治具の回転駆動機構と送り機構が必要であるため、製造設備が複雑になる。さらに、軸受素材をチャックで固定する必要があるため、チャック力によって軸受面が変形したり、外周面との同軸度に狂いが生じたりする。

【０００６】本発明の目的は、傾斜状の動圧溝を有する軸受面の成形加工を簡易な設備で、少ない工数で、かつ、精度良く行うことができる製造方法を提供すると共に、軸受本体の内部と軸受隙間との間の適切な油の循環を確保し、軸受隙間内の油の劣化を抑制して軸受寿命を向上させることにある。

【０００７】

【課題を解決するための手段】上記目的を達成するため、本発明は、軸受面における動圧溝の形成領域を成形するための第１成形部と動圧溝の形成領域以外の領域を成形するための第２成形部とを有する成形型を円筒状の多孔質素材の内周面に挿入し、多孔質素材に圧迫力を加え、多孔質素材の内周面を成形型に加圧することにより、多孔質素材の内周面に、軸受面における動圧溝の形成領域とそれ以外の領域とを同時成形する構成とした。あるいは、上記成形型を内型として、圧縮成形により粉末材料から円筒状の圧縮成形体を成形すると同時に、成形型により、圧縮成形体の内周面に、軸受面における動圧溝の形成領域とそれ以外の領域とを同時成形する構成とした。上記成形型の離型は、上記圧迫力を解除することによる多孔質素材のスプリングバックを利用して、あるいは、圧縮成形力を解除することによる圧縮成形体のスプリングバックを利用して行うことができる。

【０００８】

【発明の実施の形態】以下、本発明の実施形態について説明する。

【０００９】図１は、本発明の製造方法によって製造した動圧型多孔質含油軸受の一形態を例示している。この多孔質含油軸受１は、例えば、図２に示すようなレーザビームプリンタのスキャナモータにおいて、ロータ２とステータとの間の例磁力によって高速回転するスピンドル軸４をハウジング５に対して回転自在に非接触支持するものである。

【００１０】多孔質含油軸受１は、多孔質の軸受本体１ａと、潤滑油又は潤滑グリースの含浸によって軸受本体１ａの細孔内に保有された油とで構成される。軸受本体１ａは、例えば銅又は鉄、あるいはその両者を主成分とする焼結金属で形成され、望ましくは銅を２０～９５重量％含有し、密度が６．４～７．２ｇ／ｃｍ³ となるように形成される。軸受本体１ａの材質として、鋳鉄、合成樹脂、セラミックスなどを焼結または発泡成形し、多数の細孔を有する多孔質体としたものを用いても良い。

【００１１】軸受本体１ａの内周面には、支持すべき軸の外周面と軸受隙間を介して対向する軸受面１ｂが形成され、その軸受面１ｂに傾斜状の動圧溝１ｃが形成されている。この実施形態における軸受面１ｂは、軸方向に対して一方に傾斜した複数の動圧溝１ｃを円周方向に配列した第１領域ｍ１と、第１領域ｍ１から軸方向に離隔し、軸方向に対して他方に傾斜した複数の動圧溝１ｃを円周方向に配列した第２領域ｍ２と、第１領域ｍ１と第２領域ｍ２との間に位置する環状の平滑領域ｎとで構成される。第１領域ｍ１の背（動圧溝１ｃ間の領域）１ｄと第２領域ｍ２の背（動圧溝１ｃ間の領域）１ｄは、それぞれ平滑領域ｎに連続している。第１領域ｍ１の動圧溝１ｃと第２領域ｍ２の動圧溝１ｃとは、軸受面１ｂの軸方向中心線に対して左右対称になっている。軸受面１ｂには、動圧溝１ｃの形成領域を含む全領域にわたって表面開孔が分布しており、主に軸受面１ｂの表面開孔を介して、軸受本体１ａの内部と軸受隙間との間で油を循環させて、軸の外周面を軸受面１ｂに対して非接触支持する構成になっている。例えば、表面開孔率は、第１領域ｍ１および第２領域ｍ２において５～４０％の範囲、望ましくは５～２０％の範囲に設定し、平滑領域ｎにおいて２～３０％の範囲、望ましくは２～１０％の範囲に設定することができる。また、平滑領域ｎの表面開孔率は、第１領域ｍ１および第２領域ｍ２の表面開孔率よりも小さくすることができる。ここで、「表面開孔」とは、多孔質体組織の細孔が外表面に開口した部分をいい、「表面開孔率」とは、外表面の単位面積内に占める表面開孔の面積割合をいう。

【００１２】軸受本体１ａと軸との間に相対回転が生じると、第１領域ｍ１と第２領域ｍ２にそれぞれ逆向きに傾斜形成された動圧溝１ｃによって、軸受隙間内の油が平滑領域ｎに向けて引き込まれ、油が平滑領域ｎに集められるため、平滑領域ｎにおける油膜圧力が高められる。そのため、潤滑油膜の形成効果が高い。しかも、背１ｄに加え、平滑領域ｎも軸を支持する支持面になるので、支持面積が拡大し、軸受剛性が高められる。平滑領域ｎの軸方向幅の比率ｒは、軸受幅を１とした場合、ｒ＝０．１～０．６の範囲、望ましくは、ｒ＝０．２～０．４の範囲に設定するのが良い。尚、動圧溝１ｃは軸方向に対して傾斜した形状であれば良く、例えば図３に示すような軸方向の連続形状でも良いし（この場合、環状の平滑領域は有しない。）、あるいは、スパイラル形状でも良い。

【００１３】図４は、上記構成の多孔質含油軸受１で軸

４を支持する際における、軸方向断面での油Ｏの流れを示している。軸４の回転に伴い、軸受本体１ａの内部の細孔内に保有された油Ｏが軸受面１ｂの軸方向両側及びチャンファー部付近から軸受隙間に滲み出し、さらに動圧溝によって軸受隙間の軸方向中央に向けて引き込まれる。その油Ｏの引き込み作用（動圧作用）によって軸受隙間に介在する油膜の圧力が高められ、潤滑油膜が形成される。この軸受隙間に形成される潤滑油膜（動圧溝の動圧作用によって形成される潤滑油膜）によって、軸４はホワール等の不安定振動を生じることなく、軸受面１ｂに対して非接触支持される。軸受隙間に滲み出した油Ｏは、軸４の回転に伴う発生圧力により、主に軸受面１ｂの表面開孔から軸受本体１ａの内部に戻り、軸受本体１ａの内部を循環して、再び軸受面１ｂ及びチャンファー部付近から軸受隙間に滲み出す。

【００１４】図１に示す多孔質含油軸受１の軸受本体１ａは、例えば銅又は鉄、あるいはその両者を主成分とする金属粉末を圧縮成形し、さらに焼成して得られた図１２に示すような円筒形状の焼結金属素材１’に対して、例えばサイジング→回転サイジング→軸受面成形加工を施して製造することができる。

【００１５】サイジング工程は、焼結金属素材１’の外周面と内周面のサイジングを行う工程で、焼結金属素材１’の外周面を円筒状のダイに圧入すると共に、内周面にサイジングピン（断面円形）を圧入する。回転サイジング工程は、断面略多角形のサイジングピン（断面円形のピンの外周面を部分的に平坦加工して、円周等配位置に円弧部分を残したもの）を焼結金属素材１’の内周面に圧入し、これを回転させながら内周面のサイジングを行う工程である。軸受面成形工程は、上記のようなサイジング加工を施した焼結金属素材１’の内周面に、完成品１ａの軸受面１ｂに対応した形状の成形型を加圧することによって、軸受面１ｂの動圧溝１ｃの形成領域とそれ以外の領域（背１ｄおよび環状の平滑領域ｎ）とを同時成形する工程である。この工程は、例えば以下のようなものである。

【００１６】図５は、軸受面成形工程で使用する成形装置の概略構造を例示している。この装置は、焼結金属素材１’の外周面を圧入する円筒状のダイ２０、焼結金属素材１’の内周面を成形するコアロッド２１、焼結金属素材１’の両端面を上下方向から押さえる上下のパンチ２２、２３を主要な要素として構成される。図５（ｂ）に示すように、コアロッド２１の外周面には、完成品の軸受面１ｂの形状に対応した凹凸状の成形型２１ａが設けられている。成形型２１ａの凸部分２１ａ１は軸受面１ｂにおける動圧溝１ｃの領域を成形し、凹部分２１ａ２は動圧溝１ｃ以外の領域（背１ｄおよび環状の平滑領域ｎ）を成形するものである。成形型２１ａにおける凸部分２１ａ１と凹部分２１ａ２との段差（深さＨ）は、軸受面１ｂにおける動圧溝１ｃの深さと同程度（例えば２～５μｍ程度）で微小なものであるが、図面ではかなり誇張して図示されている。

【００１７】ダイ２０への圧入前の状態において、焼結金属素材１’の内周面とコアロッド２１の成形型２１ａ（凸部分２１ａ１を基準）との間には内径すきまＴがある。内径すきまＴ（直径量）の大きさは例えば５０μｍである。焼結金属素材１’の外周面のダイ２０に対する圧入代（外径しめしろＳ：直径量）は例えば１５０μｍである。

【００１８】焼結金属素材１’をダイ２０の上面に位置合わせして配置した後、図６に示すように、上パンチ２２およびコアロッド２１を降下させ、焼結金属素材１’をダイ２０に圧入し、さらに下パンチ２３に押し付けて上下方向から加圧する。

【００１９】焼結金属素材１’はダイ２０と上下パンチ２２・２３から圧迫力を受けて変形を起こし、内周面がコアロッド２１の成形型２１ａに加圧される。内周面の加圧量は、外径しめしろＳと内径すきまＴとの差に略等しく、内周面から所定深さまでの表層部分がコアロッド２１の成形型２１ａに加圧され、塑性流動を起こして成形型２１ａに食い付く。これにより、成形型２１ａの形状が焼結金属素材１’の内周面に転写され、軸受面１ｂが図１に示す形状および寸法に成形される（同時に焼結金属素材１’の外周面もサイジングされる。）。

【００２０】軸受面１ｂの成形が完了した後、図９に示すように、焼結金属素材１’にコアロッド２１を挿入したままの状態で下パンチ２３とコアロッド２１を連動して上昇させ（図９②の状態）、焼結金属素材１’をダイ２０から抜く（図９③の状態）。焼結金属素材１’をダイ２０から抜くと、焼結金属素材１’にスプリングバックが生じ、その内径寸法が拡大するので（図７参照）、動圧溝１ｃを崩すことなく、焼結金属素材１’の内周面からコアロッド２１を抜き取ることができる（図９④の状態）。これにより、軸受本体１ａが完成する。尚、通常の真円軸受（軸受面に動圧溝を有しない焼結含油軸受）の製造工程では、図８に示すように、軸受面（内周面）のサイジングを行った後、焼結金属素材１”をダイ２０’に圧入したままの状態で、サイジングピン２１’（断面円形：図５（ｂ）に示すような成形型２１ａは有しない。）を上昇させて焼結金属素材１”の内周面から抜き、その後、下パンチ２３’で焼結金属素材１”を押し上げてダイ２０’から取出すようにしている。この手順を、傾斜状の動圧溝を有する軸受面の成形に用いると、サイジングピン（コアロッド）を焼結金属素材の内周面から抜き取る際に、動圧溝の形状を崩してしまう。

【００２１】図１０に、内径φ３、外径φ６、幅３ｍｍの焼結金属素材１’に対して、上述した軸受面成形工程を行った時の、内径すきまＴおよび外径しめしろＳとスプリングバック量との関係を示す。同図に示すように、内径すきまＴおよび外径しめしろＳとスプリングバック

量との間には一定の相関関係があり、内径すきまＴと外径しめしろＳを特定すれば、その時のスプリングバック量も特定されることが理解できる。実験によれば、所定の深さＨ（２μｍ～３μｍ：成形される動圧溝１ｃの深さと略等しい。）において、スプリングバック量を４～５μｍ（直径量）程度に設定すれば、動圧溝１ｃを崩すことなく焼結金属素材１’をコアロッド２１から抜き取ることができたので、この程度のスプリングバック量が得られるよう内径すきまＴと外径しめしろＳとを設定するのが望ましい。尚、焼結金属素材１’のスプリングバック量の半径量が深さＨよりも大きい場合は、成形型２１ａを焼結金属素材１’の内周面に干渉させることなく離型することができるが、焼結金属素材１’のスプリングバック量の半径量が深さＨよりも小さく、成形型２１ａが焼結金属素材１’の内周面に多少干渉する場合であっても、焼結金属素材１’の材料弾性による拡径量（半径量）を付加して、動圧溝１ｃを崩すことなく成形型２１ａを焼結金属素材１’の内周面から離型できれば良い。従って、上記の実験結果に基づく寸法設定は一例であり、これによって本発明が限定的に解釈されるものではない。

【００２２】なお、軸受面１ｂの成形工程が完了した後、軸受面１ｂを通常のサイジングピン（断面円形）を用いてサイジングしてもよい。この場合、軸受面１ｂにおける背１ｄおよび平滑領域ｎがサイジングピンによってサイジングされることにより、それら領域の表面開孔率は動圧溝１ｃの形成領域の表面開孔率よりも小さくなる。また、軸受面の成形工程において、成形型によって動圧溝の形成領域のみを成形し、その後、動圧溝の形成領域以外の領域をサイジング（断面円形のサイジングピンを使用）または回転サイジング（断面円形のピンの外周面を部分的に平坦加工して、円周等配位置に円弧部分を残したサイジングピンを使用）によって仕上げることも可能である。

【００２３】以上のような工程を経て軸受本体１ａを製造し、これに潤滑油又は潤滑グリースを含浸させて油を保有させると、図１に示す形態の動圧型多孔質含油軸受１が完成する。

【００２４】真円軸受（軸受面に動圧溝を有しない焼結含油軸受）と上記方法によって製造した動圧型多孔質含油軸受（焼結含油軸受）を用いて軸振れ性能の比較実験を行った。実験は、図１３に示すようなＣＤ－ＲＯＭ実機モータに試験軸受を組み込み、市販のＣＤを実装して、回転数に対する軸振れを測定したものである。その結果を図１１に示す。同図からも真円軸受に比べ、実施形態の動圧型多孔質含油軸受が軸振れの抑制に有効であることが理解できる。

【００２５】上記の実施形態は、焼結金属素材１’に対して軸受面成形を行うものであるが、この他にフォーミング工程において軸受面成形を行うこともできる。フォーミングは、外型の内側に内型となるフォーミングピンを挿入し、内型と外型の間に粉末材料を充填した後、軸方向に加圧圧縮して円筒状に成形する工程である。このフォーミング工程において、フォーミングピンの外周面に図５（ｂ）に示すような成形型を形成しておくことによって、フォーミングと同時に成形品（圧縮成形体）の内周面に図１に示すような形状の軸受面を成形することができる。また、加圧圧縮後、圧縮成形力を除去すれば成形品（圧縮成形体）のスプリングバックを利用して成形品（圧縮成形体）をフォーミングピンから抜くことができ、この時に軸受面の形状が崩れることもない。粉末材料は金属粉末材料で、例えば銅又は鉄、あるいはその両者を主成分とするものである。フォーミング後の成形品は、焼成した後、サイジング工程、油の含浸工程等を経て製品化される。

【００２６】以上の説明では、多孔質素材又は圧縮成形体のスプリングバックを利用して軸受面の成形型を離型する場合を例示しているが、その他に、成形型を弾性的に縮拡径可能な構造とし（例えば成形型をスリットによる分割構造とする。）、軸受面の成形後、成形型を弾性的に縮径させて離型するようにしても良い。また、軸受面の形状（動圧溝の形状）に応じて、成形型の形状を変えることによって、種々の形状の軸受面を同様にして成形することができる。さらに、１つの軸受本体の内周面に複数の軸受面を軸方向に離隔して形成する場合も、外周面に複数の成形型を軸方向に離隔して形成したコアロッドやフォーミングピンを用いることによって、複数の軸受面を同時成形することができる。

【００２７】

【発明の効果】本発明によれば、動圧溝の形成領域を成形するための第１成形部と動圧溝の形成領域以外の領域を成形するための第２成形部とを有する成形型を用いて、軸受面の全領域を同時成形するので、傾斜状の動圧溝を有する軸受面の成形加工を簡易な設備で、少ない工数で、かつ、精度良く行うことができる。また、軸受本体のフォーミングと軸受面成形とを同時に行うことも可能であるので、生産性の向上とコスト低減の点でも有利である。

【００２８】本発明の製造方法によって製造された動圧型多孔質含油軸受は、軸受面の成形精度が高く、しかも、動圧溝の形成領域を含む軸受面の全領域に表面開孔が分布し、軸受本体の内部と軸受隙間との間の適切な油の循環が確保されるので、潤滑油膜の形成効果が高く、良好かつ安定した軸受機能を有すると同時に、高い耐久寿命を有する。

【図面の簡単な説明】

【図１】実施形態の製造方法によって製造された動圧型多孔質含油軸受の一形態を示す縦断面図である。

【図２】多孔質含油軸受を組み込んだモータを概念的に示す縦断面図である。

【図３】動圧型多孔質含油軸受の他の実施形態を示す縦断面図である。

【図４】動圧型多孔質含油軸受で軸を非接触支持する際の、軸方向断面での油の流れを模式的に示す図である。

【図５】図５（ａ）は軸受面の成形加工に使用する成形装置の概略を示す縦断面図、図５（ｂ）は軸受面を成形する成形型を示す側面図である。

【図６】軸受面の成形工程を示す図である。

【図７】軸受面の成形工程を示す図である。

【図８】従来の真円軸受における軸受面の成形工程を示す図である。

【図９】実施形態の軸受面の成形工程を示す図である。

【図１０】内径すきま及び外径すきまとスプリングバック量との関係を示す図である。

【図１１】従来の真円軸受と実施形態の動圧型多孔質含油軸受を使用した場合の、軸振れを比較試験した結果を示す図である。

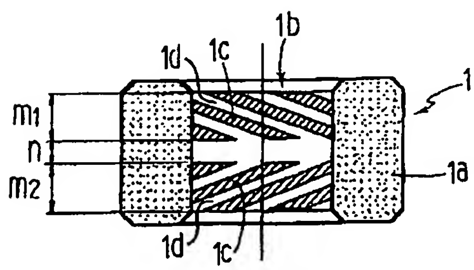
【図１２】焼結金属素材を示す縦断面図である。

【図１３】軸振れの比較試験に使用した実験装置を概念的に示す縦断面図である。

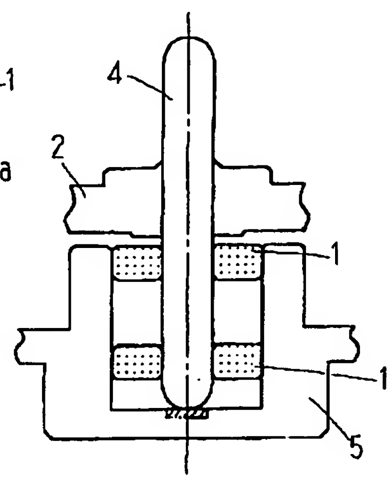
【符号の説明】

1　動圧型多孔質含油軸受
1ａ　軸受本体
1ｂ　軸受面
1ｃ　動圧溝
21ａ　成形型

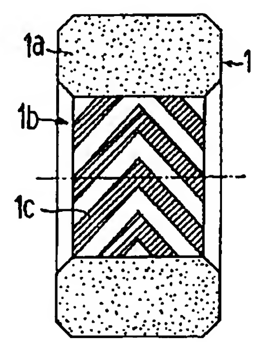
【図１】



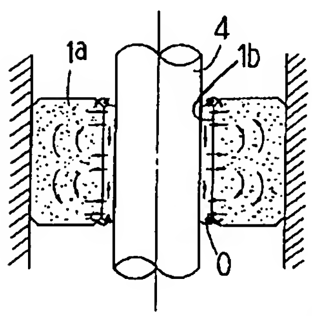
【図２】



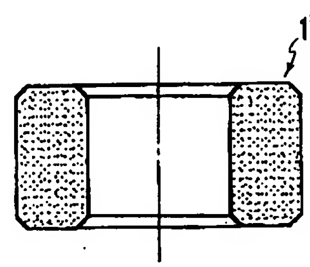
【図３】



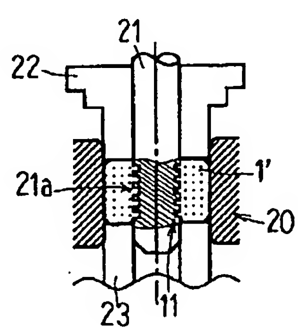
【図４】



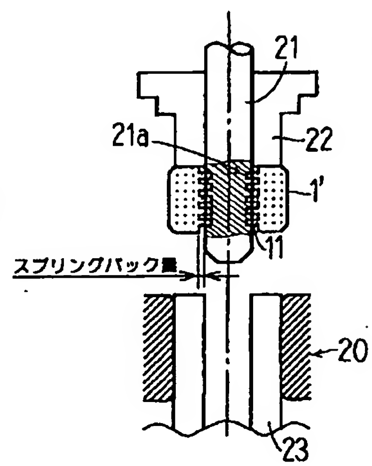
【図１２】



【図６】

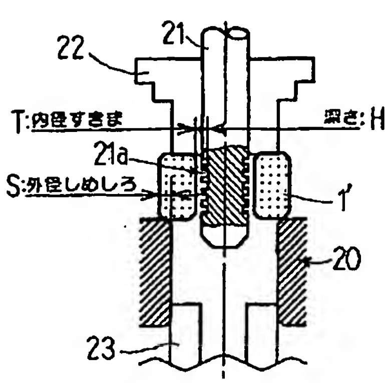


【図７】

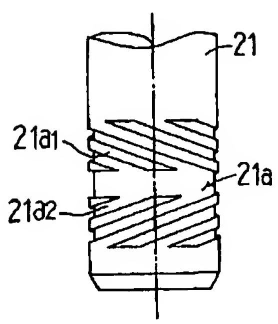


【図5】

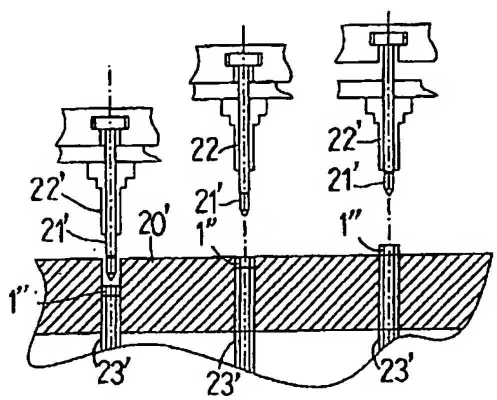
(a)



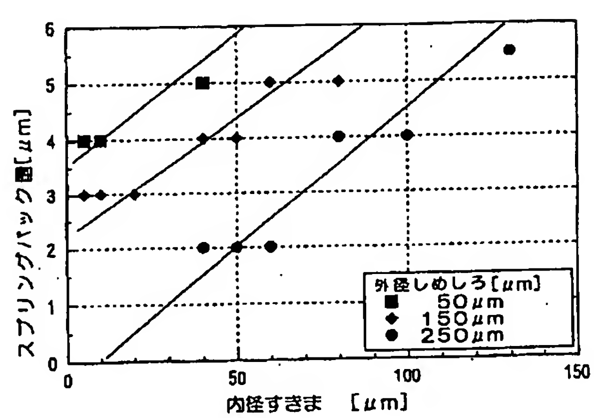
(b)



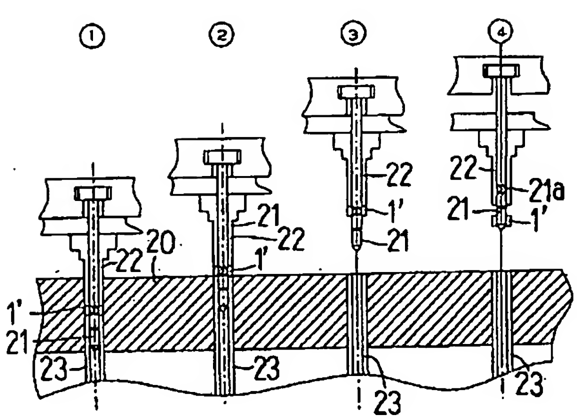
【図8】



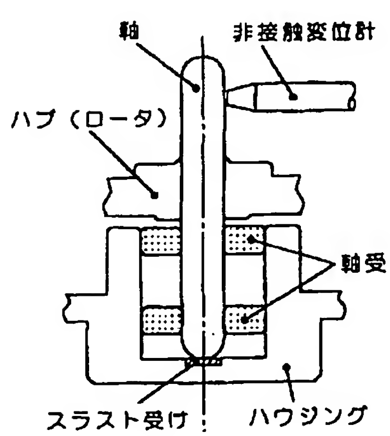
【図10】



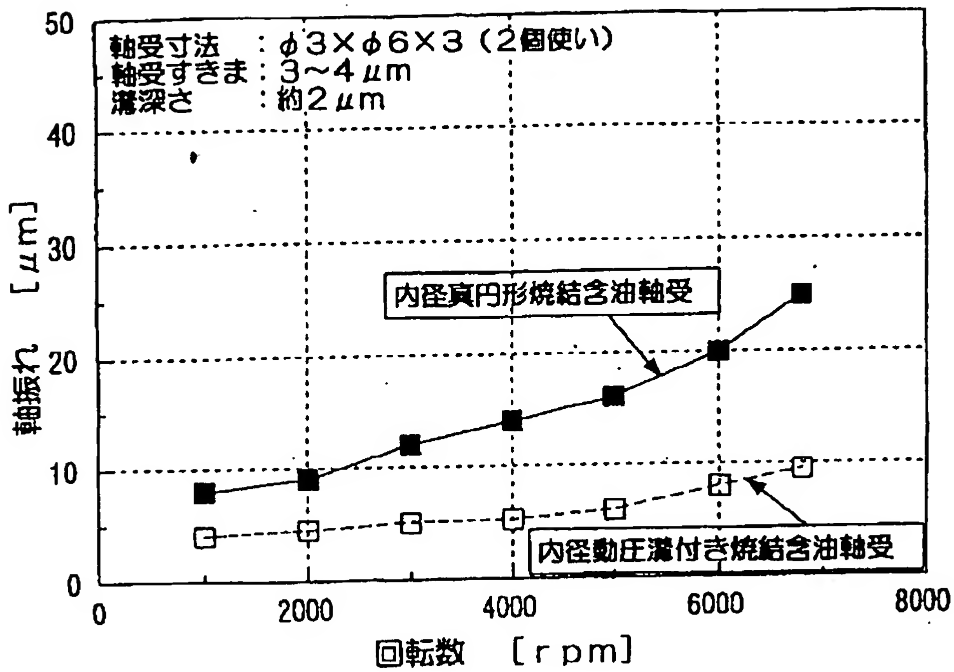
【図9】



【図13】



【図11】


軸受寸法　：φ3×φ6×3（2個使い）
軸受すきま：3～4μm
溝深さ　：約2μm
内径真円形焼結含油軸受
内径動圧溝付き焼結含油軸受
軸振れ　[μm]
回転数　[rpm]
0
10
20
30
40
50
0
2000
4000
6000
8000